1.0 Introduction

The Kendall Mine, located approximately seven miles west of Hilger, MT, has been undergoing reclamation since ore processing activities ceased in the Fall of 1997. During its operational life, approximately 460 acres were disturbed by mining operations at Kendall, and as of the end of 2000 approximately 138 acres remain to be reclaimed. Of this unreclaimed acreage, the majority encompasses the ore processing areas in Mason Canyon including two leach pads, the process plant, process water ponds, and several ancillary buildings and roads. Also included is minor resloping and backfilling of the Kendall and Barnes King mine pits as well as several access roads, mine shop facilities, and reclamation soil stockpile areas.

On February 9, 2001, the Montana Department of Environmental Quality (DEQ) and CR Kendall Corporation, owner of the Kendall Mine, entered into an agreement whereby reclamation bond money in the amount of $1,869,000 held through surety would be provided to the DEQ for the exclusive use in reclaiming the Kendall Mine (Appendix 1). DEQ will administer these funds and will have oversight and final decision-making authority over reclamation activities at the site. CR Kendall will work cooperatively with DEQ in the development of a comprehensive reclamation plan and will provide assistance to DEQ to ensure that available reclamation funds are used efficiently.

As part of the agreement, CR Kendall is to provide a closure plan to DEQ for their consideration within 30 days of the February 9, 2001, execution date. This application for a minor amendment to Operating Permit #00122 is that plan. It borrows heavily from previous closure plans, particularly DEQ's June 1, 2000, "Environmental Analysis of Revised Bond Calculations for the CR Kendall Mine," and previous minor permit amendments submitted by CR Kendall and reviewed and approved by DEQ. Deviations from these previous plans will be clearly identified. This plan differs primarily from previous plans in that it proposes an innovative, cost-efficient water management scheme wherein down-gradient users are assured of a high-quality source of water for irrigation and stock watering purposes of a volume equal to or exceeding historic levels.

1.1 Assertion of Non-Significance

This proposed minor revision to the operating permit will not adversely affect the human environment because it provides the same, or higher, level of environmental protection as the previously approved plan(s).

1.2 Organization

This application includes the following sections:

< Process Valley Closure
< Mine Pit Reclamation
< Water Management
< Performance Monitoring
< Public Access and Safety

2.0 Process Valley Closure

In January of 1999, CR Kendall submitted a request for a minor permit amendment titled Final Closure Plan for the Process Valley which compared seepage rates of various reclamation covers including Reduced Permeability Layer (RPL) covers and various thicknesses of water-balance-type cover systems. The application demonstrated little or no difference in seepage rates between RPL cover systems and a 22-inch soil cover system and therefore requested an amendment to allow a 22-inch soil cover be used as the leach pad reclamation covers. By April 1999, DEQ had reviewed the proposed changes and agreed, based upon information provided by other researchers, that a soil-cover system would be a suitable replacement for the RPL reclamation cover; however, DEQ insisted that the cover be a minimum of 36-inches of growth medium with a geotextile filter fabric between the spent ore and the overlying cap material. In its June 2000 "Environmental Analysis of Revised Bond Calculations for the CR Kendall Mine," DEQ dropped its request for a geotextile filter fabric layer, but adhered to the 36-inch soil cover stating "that 36 inches of growth medium is better that the 22-inch cover system proposed by CR Kendall, even though seepage modeling showed no significant difference in seepage through the caps." DEQ further stated that "Revegetation establishment is critical to successful reclamation, especially in the CR Kendall area where total soil volume was not salvaged. It is DEQ's opinion that a full 36 inches of soil and subsoil substitute is more beneficial than lesser amounts because a greater depth will promote better long-term stabilization and future utility by providing a medium in which to establish a dense, diverse and self-sustaining vegetative cover."

2.1 Topography

CR Kendall agrees with DEQ's rationale for the 36-inch reclamation cover system consisting of an average of 17 inches of topsoil over an average of 19 inches of subsoil. The tops of the heaps will be graded to slopes of approximately 10 percent, while the side slopes will be graded to 3H:1V. The clean fill area between the heaps will be graded to drain at approximately 2 percent. The proposed topography includes a catch drainage on the face of pad 3, and two catch drainages in the face of pad 4. The catch drainages report to the main drainages around the heaps. There will be two main drainages around the heaps: the north and south drainages. The north drainage will collect runoff from the north and east cap on pad 3 and from the north and east slopes of pad 4. It will discharge to Mason Canyon below the process ponds. The south drainage will collect runoff from the south and west faces of pads 3 and 4, and the clean fill area. The south drainage will discharge to the land application drainage south of Mason Canyon. Construction detail of these drainages is described in Section 4, Stormwater Management. The proposed final leach pad topography is shown on Plate 1, Leach Pad Final Topography and Drain Plan, and cross sections through the reclaimed pad are shown on Plate 2, Pad and Process Valley Cross Sections.

Grading on the pads will be accomplished using dozers and scrapers to move the surface material into place as needed around the edges of the spent ore piles and to achieve a final reclamation slope. It is anticipated that dozers will be the principal regrading tools.

2.2 Soil Cover Cap Construction

The soil cover cap will be constructed of materials that have been previously stockpiled on site. There is adequate soil material available to construct the 36-inch reclamation cover on the spent ore leach pads as well as other ancillary reclamation. Unreclaimed areas and their soil requirements for this plan are summarized on Table 2.1, Unreclaimed Area Summary and are shown on Plate 3, Soils and Revegetation Map which supplements Exhibit 1 in the Soils and Revegetation Plan. These reclamation volumes vary from previous plans as shown in Table 2.2, Deviation from Previous Plan, due to the fact that certain roads and ponds are proposed to remain in place. Available reclamation materials are shown on Plate 4, Reclamation Materials Locations and Volumes.
A minimum of 19 inches of subsoil will be placed directly over the regraded leach pad surface, and a minimum of 17 inches of topsoil will be placed over the subsoil surface. The topsoil will be ripped or tilled as necessary after placement to promote root penetration. Figure 2.1, Regraded Pad Tie-In, is a generalized cross-section showing the spent ore pad regrading and placement of subsoil and topsoil along the edge of the pad.

Table 2.1, Unreclaimed Area Summary

Reclamation Area	Map Acres	Slope Factor	Slope Acres	Soil Depth	Loose Cubic Yards	Type
11	0.29	1.00	0.29	14	544	A
19	4.53	1.00	4.53	14	8529	A
20	1.75	1.00	1.75	14	3295	A
21	0.80	1.00	0.80	14	1501	A
22a	0.13	1.00	0.13	14	244	A
25a	0.40	1.08	0.43	10	579	B
25b	1.12	1.07	1.20	14	2259	A
26	8.38	1.01	8.46	14	15928	A
27	0.36	1.04	0.37	8	401	C
28a	0.41	1.07	0.44	8	470	C
28b	1.67	1.00	1.67	8	1790	C
32	0.84	1.00	0.84	8	904	C
33	10.16	1.04	10.57	14	19901	A
34	2.14	1.00	2.14	14	4029	A
35	0.42	1.07	0.45	8	482	C
36	1.97	1.16	2.29	8	2450	C
38	0.86	1.01	0.87	10	1169	B
38 CAP	13.05	1.01	13.18	17	30131	B
38 CAP	13.05	1.01	13.18	19	33661	Subsoil
39	9.83	1.00	9.83	14	18508	A
39 CAP	9.91	1.00	9.91	17	22655	A
39 CAP	9.91	1.00	9.91	19	25309	Subsoil
40	1.56	1.05	1.63	10	2191	B

40 CAP	9.53	1.05	10.01	17	22884	B
40 CAP	9.53	1.05	10.01	19	25565	Subsoil
41	3.18	1.05	3.34	10	4489	B
41 CAP	21.94	1.05	23.04	17	52672	B
41 CAP	21.94	1.05	23.04	19	58842	Subsoil

Table 2.1, Continued

Reclamation Area	**Map Acres**	**Slope Factor**	**Slope Acres**	**Soil Depth**	**Loose Cubic Yards**	**Type**
42	2.79	1.00	2.79	10	3739	B
43	4.64	1.02	4.73	14	8905	A
101	0.40	1.00	0.40	10	536	B
103	2.00	1.05	2.10	8	2251	C
104	1.70	1.06	1.80	10	2415	B
105	1.63	1.11	1.81	NSN	0	
201	2.15	1.15	2.47	NSN	0	
202	1.80	1.17	2.11	10	2822	B
203	4.20	1.02	4.28	10	5741	B
204	1.51	1.00	1.51	10	2023	B
Topsoil	137.76				246,437	
Subsoil	54.43				143,377	
Total	137.76				389,814	

Table 2.2, Deviation from Previous Plan

Reclamation Area	**Map Acres**	**Slope Factor**	**Slope Acres**	**Soil Depth**	**Loose Cubic Yards**	**Reason**
19	0.53	1.00	0.53	14	964	Road
20	1.09	1.00	1.09	14	2033	Road

25B	0.20	1.07	0.21	14	391	Road
26	0.46	1.01	0.47	14	822	Road
32	0.17	1.00	0.17	8	179	Road
33	0.26	1.04	0.27	14	508	Road
38	0.64	1.01	0.65	10	874	Road
39	2.06	1.00	2.06	14	3878	Road, Pond
43	4.30	1.02	4.39	14	8202	Ponds
Total	9.71				17,851	

Figure 2.1, Regraded Pad Tie-In

Contour drainages will be constructed as shown on Figure 2.2, Typical Contour Drainage Construction. Clay lining and rock armoring materials needed for drainage construction are also available in on-site stockpiles.

2.3 Clean Fill

The area behind (west) of leach pad 4 will be filled with clean waste rock fill material and will be capped with a 36-inch cover as described above. At the west end of leach pad 4 and at the front (south) of leach pad 3, it will be necessary to raise the current topography to achieve drainage. In these areas, clean fill will be pushed in from one side and spent ore will be pushed from the other side to create a near-vertical interface between these materials as shown on Figure 2.3, Clean Fill-Spent Ore Interface. The interface between the two materials will be at least five feet inside the outer edge of the liner to ensure that any seepage through the spent ore reports to the lined area.

2.4 Revegetation

The capped heap leach pads will be revegetated in accordance with the June 1995 Soils and Revegetation Plan for Final Closure at the Kendall Mine which was reviewed by DEQ and approved in July 1995 and is shown in Table 2.3, Seed Mix. It is anticipated that no variance from the revegetation plan presented in the 1995 amendment will be required; however, demand for certain wild land species has risen dramatically due to reclamation in other areas of the State following the historic fires of 2000. As a result of this increased demand, shortages of certain species may occur. CR Kendall will notify DEQ promptly of any shortages of species included in the approved reclamation mix and solicit DEQ suggestions for replacements if necessary.

Figure 2.2, Typical Contour Drainage Construction

Figure 2.3, Clean Fill-Spent Ore Interface

Table 2.3, Seed Mix

Wet Site Blend				
%	Species	Total Germination and Hard Seed	Origin	Test
35	Rosana western wheatgrass	75 + 8 = 83%	CAN	4-96
25	Mountain brome vns	90%	CAN	3-96
7	Annual ryegrass vns	99%	OR	1-96
32	Lodorm green needlegrass	15 + 83 = 98%	CAN	5-96
1	Western yarrow	93%	CAN	6-96
Purity 95.79 Inert 3.26 Crop 0.46 Noxious 5 wild oats/# Weed 0.49 Net wt. 50#				
Dry Site Blend				
27.5	Critana thickspike wheatgrass	97%	WA	12-95
29	Secar bluebunch wheatgrass	93%	WA	6-96
8	Sheep fescue vns	96%	CAN	7-96
5	Annual ryegrass vns	99%	OR	1-96
25	Nezpar indian ricegrass	6 + 90 = 96%	CAN	2-96
4	Sandberg bluegrass vns	10 + 75 = 85%	MT	8-96
0.5	Fringe sagewort vns	6 + 77 = 83%	MT	6-96
0.3	Western yarrow vns	93%	CAN	6-96
0.7	Prarie coneflower vns	88%	CA	3-96
Purity 97.09 Inert 2.64 Crop 0.20 Noxious None found MT Weed 0.07 Net wt. 50#				
Special Blend				
15	Pryor slender wheatgrass	13 + 75 = 88%	MT	8-96
11	Thickspike wheatgrass vns	94%	CAN	8-96
14	Sodar streambank wheatgrass	97%	WA	5-96
25	Secar bluebunch wheatgrass	96%	WA	12-95
7.5	Sheep fescue vns	96%	CAN	7-96
2.5	Barkoel prarie junegrass	87%	NEL	7-96
20	Nezpar indian ricegrass	6 + 90 = 96%	CAN	2-96
5	Annual ryegrass vns	99%	OR	10-95

Purity	97.87	Inert	1.46
Crop	0.43	Noxious	1 wild oat#
Weed	0.24	Net wt.	50#

2.5 Process Ponds

During the period of performance monitoring of completed reclamation at Kendall, it is proposed that all ponds remain intact to provide contingency water storage and water management flexibility. Ponds 7 and 8 are proposed to be left intact indefinitely for storage of water to be used for irrigation purposes. Performance monitoring and irrigation management of mine waters will be discussed in detail below.

Following the performance monitoring period and providing that they are no longer needed for water management purposes, all ponds except 7 and 8 will be removed, regraded, topsoiled, and revegetated.

2.6 Process Plant and Related Structures

The process plant and its associated water treatment facilities will be left in place during the period of performance monitoring for contingency purposes. After this period, and providing the water management scheme described below is providing adequate protection of local water quality and quantity, the site maintenance, equipment, and buildings will be removed from the site. Concrete slabs and footings will be broken up and placed into open facilities such as ponds or will be placed on the leach pads or waste rock dumps in such a manner that the concrete will be incorporated into existing or anticipated reclamation. Facility sites will be graded to blend in with existing topography, and compacted areas will be ripped and the whole area topsoiled and revegetated according to the approved soils and revegetation plan. Prior to demolition of these facilities, CR Kendall will solicit local businesses and agricultural interests to determine if there is interest in their use for light manufacturing, agricultural, or other economic purpose which may contribute to the local economy. CR Kendall will promptly inform DEQ of any interest expressed in the use of existing mine facilities.

3.0 Mine Pit Reclamation

Of the six open pits mined at Kendall, four have been reclaimed and two, the Barnes King and Kendall pits, remain to be reclaimed. The low walls of both of these pits will be regraded and revegetated, safety fencing will be installed around the high walls, and berms will be constructed to limit vehicular access to the pits.

3.1 Barnes King Pit

The regrading area for the Barnes King Pit is shown on Plate 4, Pit Reclamation, Safety Fencing, and Post-Closure Access, and corresponds to the approved Soils and Revegetation Plan. The plan for the Barnes King Pit calls for using a large dozer (D-9 class or larger) to push material from the low wall side of the pit down into the pit. The dozer will push material until: (1) it can no longer dig into bedrock, (2) digging deeper would make final road construction in the area impractical, or (3) final regraded slope for the pit is achieved. The material will be pushed over the low wall side of the pit until an approximately 2.5H:1V slope is achieved.

Topsoil will be placed on all slopes of 2.5H:1V or less, including the old haul road into the pit to the extent that it can be safely accessed and as specified in the Soils and Revegetation Plan. Overall, resloped pit interiors will be low priority areas for topsoil placement should it become necessary to prioritize topsoil placement. All resloped areas will be revegetated in accordance with the Soils and Revegetation Plan.

To provide for public safety, a berm will be constructed to prevent vehicular access into the pit as shown on Figure 3.1, Typical Pit Wall Construction. To prohibit access to the high wall portions of the pit, a five-strand barbed wire fence will be constructed and tied into the berm as shown on Plate 5.

Figure 3.1, Typical Pit Wall Construction

3.2 Kendall Pit

As the Kendall Pit contains materials to be used for reclamation of other facilities, the plan for this area is to establish the final regraded slope as the reclamation materials are removed. As with the Barnes King Pit, a large dozer will be used to push material over the low wall side of the pit to establish a slope of approximately 2.5H:1V. The dozer will push material until: (1) it can no longer dig into the bedrock, (2) digging deeper would make final road or drainage construction in the area impractical, or (3) final pit reclamation slope is achieved.

Topsoil will be placed on all slopes of 2.5H:1V or less that can be safely accessed. Pit resloped interiors will be low-priority areas for topsoil placement should it become necessary to prioritize topsoil usage. All resloped areas will be revegetated according to the approved Soils and Revegetation Plan.

Once reclamation of the Kendall Pit is complete, stormwater from the Kendall Dump that is currently being diverted into the Kendall Pit will be diverted into an existing stormwater channel on the east side of the Kendall Dump pursuant to the approved Drainage and Sediment Control Plan.

To provide for public safety, a berm will be constructed to prohibit vehicular access to the low wall side of the pit. To prohibit access to the high wall areas of the pit, a five-strand barbed wire fence will be constructed that will tie in with the berm on the low wall side as shown on Plate 5.

3.3 Other Pits

The Horseshoe and Muleshoe Pits were successfully reclaimed in previous years. To provide for public safety, berms will be constructed to prohibit vehicular access to the low wall sides of the pits. To prohibit access to the high wall sides of the pits, a five-strand barbed wire fence will be constructed that will tie in with the berms on the low wall sides as shown on Plate 5.

4.0 Water Management

Key to the overall site water management strategy at Kendall is assurance of a high-quality, reliable source of water for down-stream users. CR Kendall is proposing to implement a number of cost-effective changes to water management schemes that have been previously proposed utilizing experience gained from recent water management activities on the site as well as research into possible constructive uses of what has been previously been considered waste water. In this manner, CR Kendall believes that water that has previously been considered a liability to reclamation of the site can be turned into an asset.

4.1 Stormwater Management

In January of 1996, CR Kendall submitted a Drainage and Sediment and Erosion Control Plan for the process valley to DEQ for consideration. DEQ approved the plan with only minor revisions in March of 1996. Integral to the design parameters underlying the Sediment and Erosion Control Plan was the assumption that the leach pads were to be capped with an RPL cover system. The lined stormwater drainages adjacent to the leach pads were to be keyed into the intermediate drain layer in the RPL system. For this reason, plan views of the stormwater drainage system actually show the drainage channels on the leach pad surface and diversion of up gradient stormwater onto the leach pad surface. For obvious reasons, this drainage design is no longer desirable given that the proposed leach pad cover has changed to a 36-inch soil cover design.

As part of the Drainage and Sediment Control Plan, DEQ approved construction of stormwater drainage channels directly into bedrock in areas where bedrock is encountered under a thin veneer of waste or fill rock as an alternative to the lined drainage system tied into the RPL cover. As indicated in the approved plan, channels excavated into bedrock would require little or no riprap or clay liner because the native bedrock will provide erosion- and infiltration-resistant channel lining (Sediment and Erosion Control Plan, p. 3-2). CR Kendall proposes to construct process valley stormwater drainages in bedrock as shown on Plate 1, Leach Pad Final

Topography and Drain Plan. The runoff channel dimension and calculated flow rates will remain the same as in the approved plan, though the designed routes have been shortened and isolated as much as possible to prevent high-flow, rapid-decent converging of runoff channels into large drainages.

In some cases, as in the diversion around the process facility, the existing roadway and ditches will need to be lowered. In those cases, the roadway and ditch configurations will be excavated deeper into bedrock than they currently are, and the liner will be cut and keyed-in to produce the same configuration of tie-in as shown on Figure 4-1, Typical Cut Tie-In.

Where areas of excessive permeability are suspected such as loose fill, PVC liner may be placed into the channels to prevent excessive infiltration into bedrock. Stormwater drainages that are to be lined with PVC are shown on Plate 1, Leach Pad Final Topography and Drain Plan. CR Kendall will consult with DEQ where modifications to the stormwater channel design are desired based upon site-specific conditions.

Figure 4.1, Typical Cut Tie-In

4.2 Seepage Water Management

Currently, seepage through mine-related facilities is collected at four locations: Little Dog Creek, Barnes-King Gulch, Mason Canyon, and South Fork. Seepage is pumped to one or more lined ponds and, depending upon site conditions, it is stored, treated and released into the Kendall Pit, or applied as irrigation water over previously-reclaimed mine facilities. The amount of seepage collected in each drainage is recorded using totalizing flow meters. Table 4.1 summarizes average and maximum seepage collection, or pump back, volumes for the period 1997 through 2000. Year by year pumping rates are tabulated and presented graphically in Appendix 2. A remarkable characteristic of the seepage collection volume is that it tends to be approximately 23.5 million gallons per year no matter the amount of precipitation received, though the peak pump-back rates may vary from month to month in a given year.

Pump-back water in addition to seepage from the reclaimed leach pads will be stored in ponds 7 and 8 until it is removed for irrigation purposes. These ponds currently have a combined capacity of 18.8 million gallons while retaining two feet of freeboard. To provide direct communication between the ponds, CR Kendall proposes that a 10" pipe with gate valve be installed in the berm between the two ponds to provide communication between the two ponds and to control flow. This pipe would only be installed if the water stored in the ponds is to be used for off-site irrigation; otherwise, the ponds will remain in their current configuration. Designs of the current and proposed pond configurations are shown in Appendix 3.

Table 4.1, Annual Pump Back Volumes

Month	Average Pump Back Volume				
	KVPB-6	KVPB-2	TMW-26	KVPB-5	Total
January	165,425	156,000	178,096	191,328	690,848
February	233,375	138,142	179,588	156,085	707,190
March	1,023,538	318,394	472,633	438,308	2,252,872
April	1,470,160	516,635	986,052	924,203	3,897,049

May	1,156,982	369,999	1,048,459	728,790	3,304,230
June	1,517,210	456,708	1,113,790	882,183	3,969,890
July	1,016,153	325,843	967,228	612,902	2,922,125
August	657,211	225,145	688,683	385,778	1,956,816
September	395,609	173,400	458,020	273,645	1,300,674
October	322,764	167,240	358,425	228,063	1,076,491

November	169,970	146,896	273,535	183,868	774,269
December	114,808	140,510	231,668	168,035	655,021
Totals	8,243,204	3,134,910	6,956,175	5,173,185	23,507,474

Month	Maximum Pump Back Volume				
	KVPB-6	KVPB-2	TMW-26	KVPB-5	Total
January	423,810	261,730	227,502	282,410	1,195,452

February	418,640	185,770	213,532	201,770	1,019,712
March	1,199,850	333,990	567,146	555,360	2,656,346
April	1,711,321	786,750	1,222,720	1,276,910	4,997,701
May	2,018,699	685,470	1,783,810	1,233,430	5,721,409
June	2,097,210	649,160	1,248,490	1,594,730	5,589,590
July	1,279,480	426,760	1,121,230	849,030	3,676,500

August	1,261,000	272,510	977,590	515,270	3,026,370
September	545,410	195,880	586,210	366,750	1,694,250
October	546,875	191,280	405,560	285,510	1,429,225
November	286,100	171,795	307,480	221,660	987,035
December	184,200	165,550	272,263	204,920	826,933
Totals	11,972,595	4,326,645	8,933,533	7,587,750	32,820,523

To ensure long-term protection of area water quality, CR Kendall proposes to maintain the current seepage water capture and pump-back system throughout the post-closure period. Pumps and pipelines will be replaced at 20-year intervals or as required. Water collected will be stored in existing ponds 7 and 8 and utilized for irrigation purposes either on site or off site for agricultural uses. This irrigation proposal is discussed in greater detail below. Monitoring of the pumping systems will be automated, so that in event of pump failure or maintenance demands, a local service technician will be immediately and automatically notified.

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Water quality at the South Fork and Mason Canyon pump back sites is at or very near the interim compliance concentrations "at the end of the pipe". A comparison of the average concentration of constituents of concern in these waters to the interim compliance concentrations for the period 1999 through 2000 is presented in Table 4.2, Compliance Concentrations versus Pump-Back Chemistry.

Table 4.2, Compliance Concentrations versus Pump-Back Chemistry

Mason Canyon					
Constituent	Compliance Concentrations		Pump Back Concentrations		
	KVSW-4	TMW-24A	Mean	Max	Min
Nitrate + Nitrite	10.0	10.0	7.0	13.0	4.0
Arsenic	0.050	0.050	0.003	0.009	<0.003
Selenium	0.010	0.050	0.012	0.024	<0.003
Thallium	0.100	0.100	0.025	0.040	0016
South Fork					
Constituent	Compliance Concentrations		Pump Back Concentrations		
	KVSW-5	TMW-24	Mean	Max	Min
Nitrate + Nitrite	10.0	10.0	9.4	11.1	6.4
Arsenic	0.018	0.018	0.004	0.005	<0.003

Thallium	0.020	0.020	0.029	0.054	0.017

As an alternative to capturing this water in the pump back systems, it may be desirable to allow this water to infiltrate into the ground through infiltration galleries constructed within the respective drainages. Schematics of the infiltration galleries in South Fork and Mason Canyon are shown in Figures 4.2 and 4.3, respectively. The final design of the infiltration galleries, including depth and length, will be determined after conducting a series of percolation tests. Water discharge through the infiltration galleries would pass through soils where attenuation of metals, particularly thallium, and other constituents would occur prior to re-entering the surface water down gradient from the point of discharge. The discharged water would then be available for down-stream users. The quality of the discharge water and the down gradient surface water would be carefully monitored to ensure that it meets compliance standards. Should concentrations of any parameter exceed the interim compliance standards, the pump back systems would be restarted and discharge to the infiltration galleries terminated. Note that passive augmentation of South Fork with spring water, described below, would be conducted under any scenario to assure a long-term, high-quality source of water.

Figure 4.2, South Fork Infiltration Gallery

Figure 4.3, Mason Canyon Infiltration Gallery

4.3 Surface Water Augmentation

Under Administrative Compliance Order FID 151, Docket No. WQ-00-06, dated May 30,2000, CR Kendall returns water to Little Dog Creek and South Fork from wells 6 and 7 to replace seepage water that is collected and pumped back. Water is pumped from the wells through six-inch HDPE pipe to discharge locations in both creeks as shown on Plate 6, Water Management Systems and Major Facilities. The volume of water returned in any given year is equal to the amount captured and pumped back in the previous year; thus, down-stream users are assured that any water that may have been lost to down stream beneficial uses is wholly replaced.

CR Kendall proposes to supplement, or totally replace, the current system of mechanically pumping water into Little Dog Creek and South Fork with water delivered via pipeline from spring developments in upper Little Dog Creek and Mason Canyon. Water quality analyses of these springs indicate that both springs meet all surface and ground water standards. Water quality analyses of the two springs is presented in Appendix 4. Initial volume estimates begun in the fall of 2000 and earlier measurements obtained by the Montana Department of Natural Resources and Conservation indicate that they may meet or surpass the augmentation requirements in both drainages. Any shortfall in the volume of water required to meet augmentation requirements will be pumped from water wells 6 and/or 7.

Schematic drawings of the proposed spring developments in Little Dog Creek and Mason Canyon are shown in Figures 4.4 and 4.5, respectively. Water from the head gate developments would flow by gravity through HDPE pipe across the Madison Limestone in the mine area, where it would normally infiltrate into the ground, to a point below (east) of the mine disturbance and pump back systems. The proposed pipeline routes are shown on Plate 6. The pipelines will be buried at public access road crossings to protect them from vandalism. Freezing of the pipelines is not expected to present a problem because previous experience at the site shows that low water volumes (< 3 gpm) may be pumped through surface piplines without freezing. Totalizing flow meters will be placed on each pipeline to measure the volume of water provided to each drainage for augmentation purposes.

Figure 4.4, Little Dog Creek Spring Development

Figure 4.5, Mason Canyon Spring Development

4.4 Irrigation Water Management

Water collected from the pump-back systems and seepage through the reclaimed leach pads will be collected in ponds 7 and 8 below (east) of leach pad 4. This water is of sufficient quality to be used for irrigation and/or stock watering purposes. Water analyses of the combined water is presented in Appendix 5. CR Kendall proposes to utilize this water primarily for irrigation purposes, either on site on reclamation plots through the existing irrigation system, or off site on land controlled by CR Kendall for agricultural purposes.

CR Kendall is currently permitted to irrigate utilizing seepage water on mine site reclamation plots encompassing approximately 250 acres. At any given time only a fraction of the permitted acreage, generally less than 30 to 40 acres, is under irrigation. Even so, CR Kendall disposed of 28.5 million gallons during May through November of 1999 and 33.6 million gallons between April and October of 2000. The irrigation was carefully controlled to ensure that saturated ground conditions or surface runoff did not occur. The result of the irrigation disposal of mine waters is exceptionally lush vegetation growth which has attracted abundant wildlife to the reclaimed areas. Clearly, irrigation disposal of mine waters is an attractive and pragmatic solution to water management at Kendall.

CR Kendall proposes to continue to dispose of mine seepage water through irrigation throughout the long-term closure period. If managed correctly, no long-term treatment of mine waters will be necessary because all collected seepage waters will be stored in ponds 7 and 8 and then utilized for irrigation. A water balance has been prepared that shows this strategy may be easily implemented while maintaining conservative safety margins in the event of extreme precipitation conditions. The water balance calculations are discussed in detail below.

As an alternative to irrigating on the mine site, CR Kendall is actively pursuing negotiations with adjacent ranchers for the purpose of utilizing the mine seepage waters for agricultural purposes. Water stored in the mine ponds would flow by gravity through an eight-inch HDPE pipe to the irrigated plot where water would be applied via a pivot wheel or wheel line irrigation system. Water application rates are discussed in detail below. CR Kendall would maintain control over the irrigation plots to ensure that application rates are not exceeded. Soil lysimeters and a down-gradient monitoring well will be constructed to monitor the irrigated plot.

The local land owner(s) may desire to have a bleed line attached to the main irrigation line so that some of the water may be utilized for stock watering purposes. Note that the bulk chemistry of the water is well within stock watering guidelines published by various agencies (MSU Extension Service, When is Water Good Enough for Livestock, (1998); Puls, Robert, Mineral Levels in Animal Health, 3rd ed, (1990)). In fact, this water was used for stock watering purposes in 2000 with DEQ permission. If a bleed line is to be utilized, a ball-valve mechanism will be employed to ensure that water does not overflow the stock tank(s).

Should this alternative be adopted, CR Kendall proposes that the existing mine site irrigation system remain in place as a contingency measure to handle unforseen water balance situations.

Utilizing the mine waters for off site agricultural purposes presents two distinct advantages over irrigating on the mine site: 1.) it is cost effective because water will not have to be pumped to the irrigation plots, and 2.) it converts what is normally considered a liability, i.e., the mine seepage waters, into an asset that may be utilized by neighbors of the mine. Therefore, should CR Kendall be successful in its negotiations with off-site landowners, DEQ will immediately be notified, and detailed plans for conveying the water from the ponds to the irrigation plots will be submitted as the primary water management system.

4.5 Closure Water Balance

CR Kendall has prepared a closure water balance assuming collection of seepage water from the Little Dog Creek, Barnes King Gulch, Mason Canyon, and South Fork pump-back systems, seepage from the reclaimed leach pad, storage of the collected water in ponds 7 and 8, and irrigation of the water either on site using the existing irrigation system or off site for agricultural purposes. For calculation purposes, the following assumptions are made:

1. Ponds 7 and 8 remain in place to provide storage for captured mine waters.
2. The total capacity of ponds 7 and 8 is 18.8 million gallons with two feet of freeboard. If

the berm between the ponds is removed as proposed, the pond capacity increases to approximately 20.8 million gallons with two feet of freeboard.

3. Pad seepage is estimated using DEQ’s conservative estimate of 26 percent infiltration of effective precipitation. This amounts to 8.5 million gallons per year, or approximately 16 gpm. It should be noted that HELP modeling of a 22-inch soil cover yielded an infiltration rate of six gpm; however, CR Kendall agrees with DEQ that the more conservative number should be used as a design basis.
4. Effective precipitation is calculated from data provided from Schafer and Associates, Water Balance Calculations for Major Facilities, July, 1995.
5. Average pump back rates are calculated from 1997 through 2000 data. This value, approximately 23.5 million gallons annually, has been remarkably stable.
6. Maximum pump back rates are calculated using the maximum value in any month for the period 1997 through 2000 which results in 32.8 million gallons annually, or approximately 40 percent greater than the average value.
7. Irrigation water volumes are estimated based upon and application rate of 0.25 inches of water per acre per day over a 60-acre plot (Irrigation Water Management, When, Where, and How Much to Irrigate, USDA Soil Conservation Service and MSU Exension Service, MontGuide MT8901). This equates to a volume of 407,220 gal/day.
8. No irrigation will take place during January, February, March, April, November, and December under normal conditions. Limited irrigation, approximately seven days, will take place in May only in extreme precipitation years.
9. Normally, the majority of irrigation will take place during June and July followed by occasional irrigation as pond volumes allow during August, September, and October. The peak irrigation period may be adjusted as pond volumes and seasonal conditions dictate.
10. Evaporation from the ponds surface, which can be considerable, is conservatively ignored for the purpose of this calculation.
11. Pond volumes will be managed so they will be at minimum levels going into the winter months.
12. No discharge of treated water is assumed.

Water balance calculations are presented in Table 4.3, Kendall Mine Closure Water Balance. As can be seen from this table, irrigation management of collected mine waters is a very effective solution to long term water management needs even under extreme conditions.

Table 4.3, Kendall Mine Closure Water Balance

5.0 Performance Monitoring

During the post-closure period, i.e., the time immediately following completion of dirt moving activities and revegetation, performance of the reclaimed mine will be monitored closely to ensure that the various closure systems are operating “as advertised”. It is anticipated that this initial monitoring period will last two years. Visual inspections of reclaimed mine facilities will be conducted monthly; however, the bulk of monitoring will consist of collection and analysis of water samples at key points. A proposed scheme for ground water and surface water monitoring during this two-year period is presented in Tables 5.1 and 5.2, respectively.

Table 5.1, Kendall Post-Closure Ground Water Monitoring

Groundwater Site Name	Facility or Feature Monitored	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Monthly
TMW-14	Ponds 7 and 8, Pad 4	GK N	GK IS PN	GKN		GK
TMW-15B	Horseshoe Waste Dump		GK IS			
TMW-24A	All process facilites	GK N	GK IS PN	GK N	GK N	GK
TMW-26	Process facilities underdrain	GK PN	GK IS PN	GK PN	GK PN	GK P
TMW-30A	Muleshoe Waste Rock Dump	GK P	GK IS P	GK P	GK P	GK P
TMW-36	Muleshoe Waste Rock Dump	GK	GK IS	GK	GK	
TMW-40D	Muleshoe Waste Rock Dump	GK	GK IS	GK	GK	GK
TMW-42	Kendall Waste Rock Dump	GK	GK IS	GK	GK	GK
KVPB-2 KVPB-5 KVPB-6	Muleshoe Pumpback Kendall Pumpback N.Muleshoe Pumpback	GK P GK GK	GK IS P GK IS GK IS	GK P GK GK	GK P GK GK	GK P GK GK
WW-7* WW-6* Peters Well Peters Spring Kendall Spring Sec. 29 Spring Scout Camp Well	Water Well 7 Water Well 6	GK GK GK N GK GK GK	GK GK GK IS PN GK IS GK IS GK IS GK IS	GK GK GK N GK GK GK	GK GK GK IS N GK GK GK IS	GK GK

* Only if in use

Table 5.2, Kendall Post-Closure Surface Water Monitoring

Site Name	Drainage and Facility Monitored	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Monthly
KVSW-1	Little Dog Creek, Horseshoe Waste Rock Dump	GK	GK IS	GK	GK	
KVSW-2	B-K Gulch, Muleshoe Waste Rock Dump	GK P	GK IS P	GK P	GK P	GK P
KVSW-3	North Fork Last Chance Creek	GK	GK IS	GK	GK	
KVSW-4	Mason Canyon, Process Facilities	GK PN	GK IS PN	GK PN	GK PN	GK PN
KVSW-5	South Fork Last Chance Creek Kendall Waste Rock Dump	GK	GK IS	GK	GK	GK
KVSW-6	South Branch of Little Dog Ck. North Muleshoe Muleshoe Waste Rock Dump	GK	GK IS	GK	GK	GK
South Fork at Property Boundary	South Fork Last Chance Creek 800 ft below KVSW-5	GK	GK IS	GK	GK	
Little Dog Ck spring at outlet	At section 29 spring	GK	GK IS	GK	GK	
Mason Canyon Spring at outlet		GK	GK IS	GK	GK	
Ponds 7 and 8		GK PN	GK IS PN	GK PN	GK PN	GK PN
Scout Pond	South Fork Last Chance Creek below KVSW-5	GK	GK IS P	GK	GK	GK*

Parameter sets are shown in Table 5.3 and water monitoring locations are shown on Plate 7. Following the two year performance monitoring period, CR Kendall will consult with DEQ to determine which of the monitoring site and/or parameters may be deleted or modified as necessary to provide long-term assurance of site stability.

Table 5.3, Kendall Post-Closure Parameter Sets and Detection Levels

Metals[1]					
Parameter Set K		Parameter Set S		Parameter Set P	
Arsenic	0.003	Iron	0.01	Antimony	0.003
Selenium	0.001	Manganese	0.005		
Thallium	0.002	Zinc	0.01		
Physical Parameters and Common Ions					
Parameter Set G		Parameter Set I		Parameter Set N	

pH	s.u.	Alkalinity	1.0	Total cyanide	0.005
Specific Cond.	uohm/cm	Bicarbonate	1.0	WAD cyanide[5]	0.005
Total susp. solids[2]	1.0	Calcium	1.0	Free cyanide[5]	0.02
Nitrate + Nitrite	0.01	Carbonate	1.0	Ammonia as N	0.05
Sulfate	1.0	Magnesium	1.0	Kjeldahl N	0.01
Flow Rate[3]		Phosphorus	0.005		
Water Level[4]		Sodium	1.0		
		Total Hardness	1.0		
		Total diss solids	10		

6.0 Public Access and Safety

Post closure access of the Kendall site is shown on Plate 5, Pit Reclamation, Safety Fencing, and Post-Closure Access. It consists of two principal types of access: public access, and monitoring and maintenance access.

Public access through the site will be provided from the Kendall townsite through the mine to the north and to the south. CR Kendall has executed an agreement with the Bureau of Land Management which provides the BLM with the public access roads and specifies their responsibility for long-term maintenance.

Monitoring and maintenance access roads will be maintained to the four water collection sites in Little Dog Creek, Barnes King Gulch, Mason Canyon, and the South Fork of Last Chance Creek. Other existing access roads will be maintained to ponds 7 and 8 and to the process plant area.